

Description

Helical device for conversion of fluid potential energy to mechanical energy

APPENDIX DATA

[0001] Definitions Appendix_A Generally cylindrical ☐ Describes a housing with radial symmetry but where the radius measurement may vary along the axial length. I.e., the housing may include tapers, bulges etc. Helical baffles ☐ Describes a fin-like construction from the inside of the housing toward the axis of the housing. The baffles will be generally sealed to the housing however some weep holes, access points etc. may be incorporated. A version whereby the baffles are semi-sealed but not physically connected to the housing is also claimed. The pitch of the helix may be varied along the axial length of the housing. The profile of the baffle (the cross section formed by a plane containing the housing axis and any radius) may be of a curved nature to maximize the fluid capacity, minimize frictional losses, fluid turbulence or otherwise im-

prove the efficiency of the device. AquaHelix □Proprietary term, September 2003 search indicates it is not US Copyrighted as of that time, used to describe the mechanism contained in this patent. Sealed □ The term sealed shall be taken to mean allowing minimal leakage of a fluid barrier in relation to the volume of fluid associated with the device. While the seal will generally be accomplished by solid materials, other form of seals allowing relative motion of portions of the barrier may be utilized and some degree of leakage may be expected or intentionally designed.

BACKGROUND OF INVENTION

[0002] Field of the Invention

[0003] Of commercial high capacity renewable energy sources, water has the longest history, is the most easily harnessed and has the best potential for an environmentally friendly source of energy. The invention is intended to provide a preferdevice ism for use in hydroelectric mechanisms for the conversion of potential energy in the water to mechanical energy. This energy would then be used to power electrical generation equipment or put to other productive use. The alternative methods to accomplish this that are currently in place include but are not limited to: turbines,

water wheels, hydraulic ram pumps, wave and tidal capture mechan and othersisms. Each of these has inherent negatives, many of which are addressed in AquaHelix the mechanism herein described. The de hereinvice has the potential for retrofit in existing hydroelectric dams and well as in new construction and smaller personal installations. The simplicity of this device may make the cost and effort of operation appealing in otherwise unfeasible situations for conventional technologies

[0004] Description of Prior Art:

[0005] Minimum prior art of this nature has been discovered. The concept utilized in typical cement mixer trucks actually has similar characteristics albeit run in a reverse fashion, and for the purpose of mixing in a closed recycled nature rather than for transport and energy conversion.

[0006] A search of prior art in the area of this invention reed in the the following related but differentiated patents. Substantial differences between claims herein and prior art is described below.

[0007] US PTO #6,253,700 covers the use of a helical blade submerged in a fluid flow in an attempt to convert energy. The claims of that patent differ in numerous ways from that covered herein, but most significantly in that the ba-

sic concept and design is to convert the kinetic energy of moving fluid to mechanical energy via a foil effect versus the basic design covered herein to extract potential energy from a fluid by a change in elevation into mechanical energy.

- [0008] US PTO #4,268,226 covered a scheme whereby the internal volume of a tube is changed by a helical constraint around a pliable tube that cause a pumping action when the assembly is subjected to distortion. This patent also differs in substantial ways, the greatest of which is the lack of helical baffles that constrain a fluid.
- [0009] US PTO #4,465,430 covered a scheme whereby a stationary helix is utilized to impart a swirl motion to fluid prior to entry into a turbine or propeller to improve efficiency of the turbine or propeller. The device claimed herein is not designed to optimize efficiency of a subsequent step such as a turbine or propeller; it is an energy conversion device in its own right.
- [0010] US PTO #4,871,304 describes a compressor consisting of a spiral grove and blade along the length of a cylinder, the geometry of the device varies along its length such that the fluid is compressed in volume as it moves from input to output. The device claimed herein is not designed to

compress fluid, nor does it rely on the relative motion of internal and external rotating bodies or a blade fitted to a helical grove.

- [0011] US PTO #'s 6,253,700 and 6,293,835 describes a plurality of air foil shapes blades to be utilized in conjunction with a ultra low-head fluid in order to extract or impart kinetic energy from or to a fluid or gas. The device claimed herein differs in substantial ways, the most significant of which is the necessity for a material fluid head and lack of the requirement of air foil shapes blades or material kinetic energy in the fluid or gas.
- [0012] US PTO #6,257,855 describes a compressor consisting of a set of helical rotors which intermesh in order to create a positive displacement pump for creation of pressure or vacuum. The device claimed herein differs in substantial ways, the most significant of which is the lack of necessity for dual intermeshing helical rotors.
- [0013] US PTO #6,273,673 describes a pump consisting of a helical baffle through which one or more balls are transported resulting in the displacement and transport of the surrounding fluid. The device described herein among numerous differences does not rely on the use of balls in the helical channels.

- [0014] No other patents or demonstrations of similar technology have been discovered in USPTO searches or during research and development of this patent.
- [0015] Unmet Opportunity in the Industry
- [0016] With the recent power shortages, middle eastern oil concerns and national attention to energy costs, this device offers an attractive solution to harnessing more energy from existing and new hydroelectric generation dams and providing a solution for smaller installations for personal use, industrial use or sale back to the power grid under PUC net metering regulations. The device offers a potentially significant improvement in the conversion efficiency, offering more power from existing installations or the same power from fewer installations.
- [0017] With the growing concern over the regrettable killing of fish and marine animals in hydroelectric turbines, this invention will be particularly attractive. It should dramatically reduce this problem by eliminating the high speed under water blades and the small volumes of "uncleaved" water that pass thru the turbines and well as dramatically reducing the turbulence and velocity that the water and wild life are subjected to in traditional turbine installations.

BRIEF DESCRIPTION OF DRAWINGS

- [0019] Drawing 1 This drawing portrays the effect of larger and smaller helix pitch on the volume of liquid in the device. Smaller pitch results in higher volume.
- [0020] Drawing 2 This drawing portrays the effect of larger and smaller helix pitch on the spill effect at the exit of the device. Smaller pitch result in less potential energy loss at discharge.
- [0021] Drawing 3 This drawing depicts a baffle cross section with a high volume of water captured in a helix turn
- [0022] Drawing 4 This drawing portrays a baffle cross section with low surface area of the baffle in contact with the fluid
- [0023] Drawing 5 This drawing portrays the effect of larger radius and helix pitch at the entrance of the device
- [0024] Drawing 6 This drawing portrays the effect of larger radius and helix pitch at the exit of the device
- [0025] Drawing 7 This drawing portrays the design of a bulb shaped entrance utilized a siphon feed technique
- [0026] Drawing 8 This drawing portrays the change in input elevation via shortening or lengthening of the device
- [0027] Drawing 9 This drawing portrays the change in input ele-

vation via changing the angle of the device

[0028] Drawing 10This drawing portrays a 3 dimensional view of the preferred embodiment of the device

DETAILED DESCRIPTION

[0029] A helical baffle is fabricated inside of a generally cylindrical housing such that when the device is oriented on an axis, that open cavities are created in each of the helical turns between the baffle and the interior walls of the cylinder. As the laws of physics allow that in a steady state situation, fluid pressure applied to a surface acts perpendicular to a tangent of the surface, that portion of the fluid contacting the helix will result in a moment of force around the axis of the cylinder and a component of force in the downward axial direction. A component of force will also be developed in the radial direction if a helical profile is utilized that is non-perpendicular to the axis of the housing. The remainder of the fluid will act on the walls of the cylinder creating additional forces in radial directions. As both radial and axial motion will be constrained by a supporting structure, no energy will be extracted from the fluid from these components of force. The remaining rotational or moment forces will result in rotation of the helix and housing (not notwithstanding claim 8). As the rota-

tional speed is kept relatively low in this deviforces, it will appr a ach physistatic ady state conditions as the magnitude of frictional and kinetic forces of the water will be low compared to those forces described above. Said otherwise, the frictional drag of the fluid against the baffle and housing walls will be small as compared to the forces generated by the pressure of the fluid. The resulting force vector will cause the assembly to turn about the cylinders axis when adequate bearings or other friction reducing mechanism is utilized to allow the device to rotate. The axial vector of force fluid as well as the weight of the device itself will simultaneously create a tendency for a downward movement along the cylinders rotational axis and therefore will require some form of constraint such as a thrust bearing to constrain axial movement.

- [0030] Mechanical energy can then be extracted from the rotation of the device either by gearing, belts, frictional or other means from the surface motion of the outside of the housing, or by an axial off take thru the middle of the struc or by other meansture. This mechanical energy can then be utilizeddesired ent as an energy source for subsequent operations such as electrical generation.
- [0031] The improved efficiency of this device verses conventional

turbines is derived primarily from the decreased kinetic energy present in the discharge of the fluid and from decreased viscous frictional losses. The basic mechanism of most devices in the hydroelectric realm (a principle focus of this invention) is the conversion of energy from potential en(r)gy, mass (water) at an eleva)ion, to residual potential en (gy, mass (water) at a lower eleva)tion and mechanical energy that can be harnessed and utilized typically for the production of electricity. The efficiency of the conversion to mechanical energy is dependent on the amount of energy lost to other unharvested forms specifically frictional energy and kinetic energy of the fluid at discharge. Frictional energy ultimately shows itself as heat, either in the mechanism, the air or in the fluid. Kinetic energy is attached to and wasted in the form of mass in motion of the fluid at the discharge of the device. The relative magnitude of energy in each of these forms calculated below and is instructive to see the potential savings of the described device. As the speed of revolution of the device is slowed to approach 0, so do the loss to kinetic energy and the loss to viscous friction (heat gain) of the fluid. The calculation below is instructive as to the magnitude of potential gains from the device.

[0032] 100 tons of water with potential to descend 100 ft contains 7.53 Kilowatt-hours of energy

[0033] Joules = kg mass * 9.81 m/sec²(gravity) * meters height

[0034] joules = (100 ton * 907.185 kg/ton)* 9.81 m/sec² * 100 ft * .3048 m/ft = 27,126,000 Joules

[0035] 27,126,000 joules / (3,600,000 Joules/KW-hour) = 7.532 Kilowatt-hours of energy

[0036] 100 tons of water traveling at 20 miles per hour at discharge contains 1.01 Kilowatt-hours of energy

[0037] Joules = $\frac{1}{2}$ * kg mass * m/s velocity²

[0038] Joules = $\frac{1}{2}$ * (100 ton * 907.185 kg/ton) * 20 mph * 20 mph * (.44704 (meters/sec) / mph) * (.44704 (meters/sec) / mph) = 3,626,000 Joules

[0039] 3,626,000 joules / (3,600,000 Joules/KW-hour) = 1.01 Kilowatt-hours of energy

[0040] 100 tons of water raised .1 degree Fahrenheit from viscous friction absorbs 1.48 Kilowatt-hours of energy

[0041] 100 tons * .1 degree F * 5/9 degree C / Degree F * 907184 grams/ton = 5,039,900 gram-degree C

[0042] 5,039,900 gram-degree C * 1 BTU/gram-degree C * .29307 watt-hour/BTU = 1,477,043 watt hours

[0043] 1,477,043 watt hours .001 KW-hour / watt-hours = 1.477

KW-hours

[0044] While a 20 mph discharge speed and .1 degree F discharge water temperature gain are crude estimates, the benefit of reductions in these areas are significant, the combined losses of 2.49 Kilowatt-hours being 1/3 of the potential energy (7.53 Kilowatt-hours) that could be obtained. The temperature change, while real in concept has the further complication of an evaporative cooling effect that becomes significant in the turbulent discharge of traditional hydroelectric dams where portions of the wasted kinetic energy hasten evaporative heat transfer and result in re-cooling the water, potentially cooler than the entrance temperature. However, despite this countering effect on the water temperature, the viscous losses due to high turbulence and turbine shear are no less wasteful in traditional hydroelectric turbine technology. As the size of the AquaHelix carrying a given volume increases the rpm of the device decreases and as the rpm approaches zero the kinetic and viscous frictional losses also approach zero. An optimization of the higher cost of construction and the frictional losses in the larger device itself countered by the lower kinetic and viscous frictional losses would be utilized to size the device and determine the optimal operating

rpm.

[0045] The helix pitch of the baffle can also be optimized to maximize the net power obtained. This would be accomplished by lab modeling and measurement of the net rotational energy obtained from various pitches for a given fluid and housing diameter. As the helix pitch is decreased, more turns, the total fluid volume and therefore conversion potential contained in the device at any point in time would increase (See Drawing 1). In addition the lost potential energy due to the spilling effect at the exit would also be reduced (See Drawing 2). However, as the helix pitch is decreased surface area exposed to a given amount of fluid is increased and therefore the viscous frictional losses are larger. Weight of a lower pitch device would also be increased and thereby increasing the losses to friction in the rotational and thrust bearing surfaces. The optimal pitch will be a function both of the fluid characteristics and the diameter of the housing as well as the cross section of the baffle as discussed b

[0046]

[0047]

[0048] The cross section of the baffle can also be optimized to

maximize the net power obtained. This would be accomplished by optimizing the baffle design to carry more fluid per turn of the helix versus the viscous fluid losses of various cross sections. A cross section with base parallel to the fluid surface (horizontal) and a minimal interior radius would increase fluid per turn of the helix (See Drawing 3). However, the ratio of fluid volume to surface in contact with the housing and baffle can also be optimized for various angles of the baffle (See Drawing 4). The optimal design will be a compromise between these two extremes that provides the maximum net power obtained for a given fluid and housing characteristics. The exact profile of the baffle will be optimized through lab and prototype experimentation.

- [0049] The radii of the housing as well as the radii and pitch and baffles may vary along the axial length of the device in order to further optimize the conversion of energy or for physical design considerations, for example:
- [0050] 1. The top, input end of the device may be of increased radius and helix pitch in order to better accept the inflow of fluid. With a larger radius and pitch fluid can be entered more easily and the average "drop" of fluid which wastes energy to kinetic and heat forms can be

minimized and the depth of the fluid going into the device would be lessened (See Drawing 5) thus reducing loss potential energy associated with introduction of fluid into the device.

- [0051] 2. The bottom, exit end of the device may also be increased in diameter and pitch to decrease the inefficient spill at the exit as well as extracting some of axial direction kinetic energy from the fluid by slowing the exit velocity (See Drawing 6).
- [0052] 3. A bulb shaped top, input end, may also be utilized with a siphoning configuration to provide for an effective sealing effect between the source of the fluid and the conversion device (See Drawing 7). This concept has potential additional advantages of allowing the supply reservoir to be somewhat remote from the device. This could potentially be upstream of an area of rapids where the accumulated elevation fall is adequate for power generation but where no individual "fall" is of sufficient elevation. The configuration would also lend it self to adjusting for changes in the supply reservoir elevation such as when it may become lower than the entrance of the housing.
- [0053] The input elevation can also be adjusted by shortening or lengthening the input end of the device, see Drawing 8 or

by changing the angle of the device, see Drawing 9. This may be desired to accommodate optimal entry of the fluid as the level of fluid in the supply reservoir may vary.

[0054] As stated in several of the discussions of the invention detail above, the viscous friction between the surfaces of the housing and baffles with the fluid results in waste. Consequently the surface treatment to minimize friction will be important to address as will the consistency of the geometry of the fluid chamber as the device turns. The discussions of advantage from varying radii and helix pitches above will need to be optimized against these countering losses as both viscous friction and turbulence from changes in geometry will result in efficiency losses.

[0055] At the center of the device along the axial length the baffles may be left open to allow overflow from one chamber to the next. This will provide a self-priming nature to the device. As fluid is entered into the first baffle area, in the event that the torque generated is not adequate to begin rotation of the device when the chamber becomes full, the fluid will then spill over to the subsequent chamber, and so on, until adequate torque is developed. Relatively small seepage holes may be utilized at the circumference to accomplish drainage of the device when it is not in opera-

tion.